

<u>Ownership matrix</u>	USQ # N/A-4
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1.0 PURPOSE AND SCOPE

This document provides a standard to be applied to all engineering Calculation Reports, regardless of safety classification, that are produced by vendors utilizing their quality assurance program.

This standard ensures that calculations are complete, clear, and, sufficiently detailed such that a person, technically qualified in the subject, can review and understand the work and verify the adequacy of the results without recourse to the originator.

The following calculation products are not subject to the requirements of this standard:

- Computations
- Business, financial, or non-technical calculations (Unless directed to do so by contract requirements)
- Calculations performed to check or verify another calculation, software, or spreadsheet.

2.0 IMPLEMENTATION

This standard is effective for all vendor calculations started after the date shown in the header. Deviations to any requirements of this standard require written approval by WRPS.

This standard shall be implemented through inclusion in the vendor contract documents.

3.0 STANDARD

3.1 Calculation General Requirements

1. The format for the Calculation Report shall include the required elements as identified in Section 3.2.
 - The direction provided for each format element (Sections 3.2.1-3.2.14) shall be addressed in generation of the Calculation Report.
 - For a calculation that is to be repurposed (copied in whole or in part) from a previous work, the required elements of this standard shall be included in the new Calculation Report.
 - For a calculation that is to be revised from a previous work, the required elements of this standard shall be included in the new Calculation Report revision. This requirement is intended for major additions to or revisions of the source calculation; however, deviations require approval per Section 2.0.

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2. The Calculation Report shall include consider the following:
 - All calculation steps are shown
 - Product is legible. This includes attachments, handwritten portions, figures, and copies from other sources
 - Identification of units provided in the calculation steps and the reporting of results
 - Succinct explanation of the calculation method and computations, yet detailed enough to permit a qualified verifier/checker to perform the technical review with minimal interpretation of the facts presented and without recourse to the preparer
 - The critical requirements for demonstrated compliance with National codes and standards and TOC engineering standards shall be identified
 - Calculations shall be completed and released prior to use as input for a follow-on calculation (unless used as an unverified assumption or if released concurrently as a package)
 - The calculation applicability shall be clearly stated
 - The calculation shall cover the entire operating range specified (e.g., range of motion, temperature, pressure, flowrate, etc.)
 - The limits of applicability shall be defined and clearly stated
 - There are no contradiction between requirements within the Calculation Report, nor with other related documents unless the contradictions are clearly identified and justified.
3. The Calculation Report should consider the following:
 - Including specific citation or cross-reference of attached information at the point of use in the calculation
 - Including only the content that is necessary and required to meet the defined objectives
 - Excluding calculations not needed to support the conclusion
 - Avoiding ambiguous terms and statements.
4. The calculations shall be checked in accordance with the vendors approved Quality Assurance (QA) program.

3.2 Format and Content

Include the following sections in the body of the Calculation Report that are marked “required.” Other sections may be added as needed. The order of the sections given below is optional but preferred:

- Objective/Purpose (required)
- Summary of results and conclusions (optional depending on calculation length or complexity)
- Introduction/background (optional)
- Input data (required)
- Assumptions (required if assumptions are made)
- Method of analysis (required)
- Use of computer software (required if computer software is used)
- Results (required)
- Conclusions (required)
- Recommendations (required if calculation results in recommendations)
- References (required)
- Calculation (required)
- Design Verification (required when design verification is required)
- Attachments and appendixes (optional).

The content requirements and considerations are detailed in the sections below.

3.2.1 Objective/Purpose (Required)

The objective, use, and applicability of the Calculation Report shall be clearly stated.

1. The intended purpose of the engineering calculation shall be clearly stated and address the question of “Exactly what does this calculation intend to provide?”
2. The calculation shall demonstrate compliance with TOC Engineering standards identified.
3. The desired output shall be specified.

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4. When preparing a new or revised calculation that is to be used to implement the safety basis, this element must be included in the scope of the calculation.

3.2.2 Summary of Results and Conclusions (Optional)

This section is an executive summary of the calculation. Consider summarizing results and conclusions for lengthy or complex calculations highlighting the key points. The results and conclusions presented here shall be consistent with those presented in the Results and Conclusions sections.

3.2.3 Introduction Background (Optional)

Background information needed to understand the Calculation Report “Objective Purpose” should be provided. Enough information should be provided to understand the context of the Calculation Report.

3.2.4 Input Data (Required)

Inputs shall be accurate and sources shall be documented. Information that serves as input to the calculation shall be referenced to the source. Attachments shall be provided showing the reference source, as necessary.

1. Inputs shall be identified and sources listed in the calculation.
 - a. In documenting input data, preference should be given to providing the information in a numbered list format with a description of the type of input data used and the reference from which it was taken.
 - b. Only inputs used within the calculation are to be listed.
 - c. Information used to produce a hand calculation or used as input for a computer code or spreadsheet must be explicitly stated, or be included in an attachment that will be part of the calculation. (It is not intended that impractical attachments, such as voluminous databases, be included.)
 - d. Data files used in computer codes, with associated software release numbers or dates, shall be listed. Enough information shall be included in the report to allow a complete reconstruction of all the input cases. This may include publishing all input files used to reach the conclusion(s) in the calculation.
2. Inputs should be obtained from controlled and approved documents or standard reference sources.
 - a. Inputs obtained from uncontrolled or unapproved sources (e.g. e-mail, correspondence, verbal communication) shall be documented and justification for use provided. It is expected that inputs from uncontrolled or unapproved sources are to be rarely justifiable; however, if inputs are obtained from these types of sources, then a documented reasonable justification is required.

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- b. An input that has no direct reference and is assigned a value or condition for the purpose of preparing a calculation is an assumption and is addressed in Section 3.2.5.
3. Codes and standards applicable to the calculation shall be listed. Where the calculation is governed by national codes and standards, the applicable codes and standards shall be identified and the calculation shall ensure that specified methods or approaches are used.
4. Where not governed by a cited code or standard, the margin or factor of safety shall be clearly stated and its basis.
5. When repurposing an existing, or an old calculation, the inputs for the source calculation shall be verified and justified to be appropriate for use as the new calculation inputs. The objective for the new calculation shall be verified to be appropriate compared to the source calculation objective. For a repurposed engineering calculation with a different intended purpose than the source calculation, justification shall be provided.
6. Use of design inputs shall be traceable at the point of use within the engineering calculation.
7. Process specific data used as input should be representative of the expected operating conditions.
 - a. When used, sources of process specific data shall be included
 - b. Process specific data used as input shall be included as a reference (as an attachment to the engineering calculation or to another source for the information).
 - c. Specific equipment sizing or selection objectives shall be stated.
8. Boundary and initial conditions (including those used in finite element analyses) shall be clearly defined and justified. This includes effects with interfacing systems, structures, and components (SSCs) and physical phenomena (e.g., structural loads, temperatures, flow rates, pressures, chemical contents, voltages, and currents).
9. Interfaces between existing SSCs and the new design shall be identified. The interaction between the two shall be detailed. Loads shall identified that must be accounted for, or constraints the existing SSC will impose on the new design.
10. Limits of the existing SSC the new design may not exceed shall be identified. Existing analysis, or inclusion of the existing SSC in the new analysis shall be referenced. Where original code limitations or factors of safety are not available, a technically justified assumption shall be provided stating the limits of the existing SSC was analyzed against.
11. Interfaces with other portions of the design.

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12. Interfaces with preceding, or subsequent portions of the design being performed by others. When starting the next phase of design; identify all relevant limitations, parameters, and considerations the previous design agent provided with the preceding portion of the design. When developing a design that relies on subsequent design work that will be performed by others; provide all limitations, parameters, and considerations that may be needed to ensure the design scope analyzed here will function correctly, and not be damaged.
13. Interface limits for future connected equipment shall be identified.
14. Limitations of use, restrictions, protection against misuse shall be identified.

3.2.5 Assumptions (Required if assumptions are made)

An assumption is an input that has no direct reference and is assigned a value or condition for the purpose of preparing a calculation. Assumptions are used to bound inputs or requirements to simplify the analysis. Assumptions are also used to allow analysis to proceed where it would otherwise need to be suspended until verification is completed.

In documenting assumptions, preference should be given to providing the information in a numbered list format with the assumption type, a description of the assumption, and the justification for use. Use of assumptions shall be traceable at the point of use within the engineering calculation. Assumptions that are stated must be used within the calculation.

Assumptions are either Technically Justified or Unverified. Technically Justified Assumptions shall be included in the "Input" section of the calculation report. Unverified Assumptions shall be included in the "Recommendations" section of the calculation report.

1. Unverified assumptions shall be clearly stated.
 - Unverified Assumptions that will not be verified by the vendor shall be clearly identified as such. The reason the assumption cannot be verified by the vendor, and the vendor's recommended verification method shall be stated.
 - Checking by testing after initial release shall be listed as an unverified assumption.
 - The use of testing as a checking method for calculations produced using software that is not pre-verified is to be listed as an assumption requiring verification. Test results that validate the calculation are to be provided to verify the assumption.
2. Technically Justified Assumptions shall be clearly stated, and the basis for the justification included. Acceptable justification methods are provided, but not limited to the following:
 - Data that is shown to have a negligible impact on the final results. This may require a supplementing calculation or computation to be shown
 - Data that is part of a permitting, performance, or operational requirement. This data is typically a design requirement and therefore justified as design input

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- Engineering judgment used for justification shall be clearly stated and justified
 - Experience with similar conditions may be used with clear and complete justification of the relevance.
 - Qualitative comparison using basic engineering principles may be used.
 - Only utilizing the simple statement of “engineering judgment” as a basis is never acceptable.
- Past practices or successes may only be used as the basis for verification with clear and complete justification of the relevance and consideration of the differences between the configuration and conditions.

3.2.6 Method of Analysis (Required)

The method of analysis (methodology) shall be clearly defined. The method needs to “stand alone” in quality and completeness so that a reasonably knowledgeable person would not have to seek the originator’s input on the methodology used in order to arrive at the same conclusions.

1. A brief description of the method of analysis shall be provided.
 - a. The method should use recognized national standards wherever possible.
 - b. For multiple cases being analyzed, each case and any differences in methodology shall be described.
 - c. Provide diagrams, sketches, photographs, or drawings to clarify extent of the calculation and provide visual association with the actual configuration.
2. Deviations from a prescribed approach shall be identified and justified.
 - a. For repurposed products, the source product shall be evaluated for deviations from the prescribed approach.
 - b. Simplifications in the calculation methodology are to be noted and justified.
3. Relevance of the methodology selected shall be justified by verification of the following:
 - Calculation approach is appropriate for the application being evaluated
 - Model or correlation validity must be demonstrated if a formula has been taken from an unpublished reference (e.g., internal memo) or was developed by the engineer/analyst
 - Calculation approach is appropriate for the range of conditions being evaluated

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- Modelling is appropriate for the application being evaluated
 - Material properties are correctly assigned.
 - Connection points are appropriately represented.
 - Mass and location are correctly assigned.
 - External loading is appropriately represented.
 - Modeling practices are consistent with computer software vendor instructions.
- For the method in a new calculation that is repurposed from previous work, the following shall be considered:
 - The source calculation shall be clearly identified
 - The repurposed method shall be justified for applicability
 - Any individual responsible for selection or approval of the method used in the source engineering calculation shall not be utilized for verification of the repurposed engineering calculation.

3.2.7 Use of Computer Software (Required)

1. If no software is used, include a statement to that effect in this section.
2. Documentation of computer software, or multi-use spreadsheet used to perform the calculation shall include the following.
 - Calculation software name
 - Calculation software revision identifier
 - Reference to, or statement that the software is being used in accordance with the vendor's quality assurance program for use of software in calculations. This may include one or more of the following:
 - Reference to vendor documentation governing the software; such as a software management plan or software quality assurance plan
 - Reference to vendor documentation of the software verification and validation (V&V) plan, testing, and results, as applicable.
 - Documentation required by the vendor's policies, procedures, software management plan, or software quality assurance plan to be included with the calculation document when the software is used. This may include:
 - Identification of the computer make and model

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- Identification of the computer’s operating system name and build number
 - Software use checklist
 - Evidence that known or identified calculation software limitations and errors for the version being used have been evaluated. These limitations and errors are typically reported to software owners through bulletins or notifications.
3. Documentation is not required for computer programs that are used only to prepare the document and/or that do not perform computational functions (e.g., Word®, Visio®). It is also not required for programs for which the computations are transparent and are directly verified via the checking process (e.g., MathCad).
 4. The following information shall be included, as a minimum, in this section for each spreadsheet used in support of the calculation:
 - Software and version used to create spreadsheet (e.g., Excel® 2013)
 - File name and version of spreadsheet
 - Methodology shall be described in this section or in a separate appendix.
 5. Single-use spreadsheets shall be checked in accordance with the vendor’s procedures to ensure correct results are produced.
 6. An input report that shows ALL of the inputs (settings, options, model data, etc.) used with the software that are relevant to the results shall be attached to the Calculation Report. Settings that do not affect the results do not need to be provided (e.g., user interface settings or preferences).
 7. An output report that contains the results supporting the conclusions shall be attached to the Calculation Report. Not all output report data available from the computer software is required. Additional output report data may be included as needed to support checking/verification, provide context for the reader, or for other reasons at the originators discretion.
 8. Submit with the Calculation Report, electronically, any native input or output computer files that are used or generated by the computer software.

3.2.8 Results (Required)

1. The calculation results shall be traceable to the stated objective(s).
 - a. Results shall demonstrate that the operating range (if specified in the calculation objective) is covered.
 - b. A description of the application of the results and where they are next used shall be provided.
 - c. Specification of the limits of the results shall be provided.

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2. The calculation results shall be traceable to the calculation details (Section 3.2.12).
 - a. Results that are not directly drawn from the calculation details shall not be presented.
3. Compliance with the critical code and standard requirements (Section 3.1) shall be demonstrated. The results relative to limits specified in codes listed as an input shall be provided, if applicable.
4. Presentation of the results should be clear and concise.
 - a. The number of significant figures reported in the results shall be consistent with the quality of the input data and propagation of uncertainties.
 - b. Additional analysis or calculations shall not be included in this section.
 - c. Conclusion statements should not be included in this section.
 - d. Extensive lists of data should be avoided.
 - e. Inclusion of intermediate results should be avoided.

3.2.9 Conclusions (Required)

Conclusions are the interpretation of the Results (Section 3.2.8).

1. Conclusions shall be traceable to the Results (Section 3.2.8).
 - a. The degree to which the objectives and purpose have been met shall be described.
 - b. The appropriateness and completeness of the results for the intended purpose shall be described.
 - c. New information in the conclusion shall not be presented; only draw on information previously presented in and supported by the body of the Calculation Report.
 - d. Every conclusion listed shall support the objective of the calculation.
2. There should be no contradiction between different conclusions within the Calculation Report, nor with other related documents unless the contradictions are clearly identified and justified.
 - a. Contradictions and inconsistencies with other documents shall be noted and the approach for resolution of the differences and corrections needed shall be stated.

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3.2.10 Recommendations (Required if recommendations are made or for Unverified Assumptions)

1. Recommendations shall be clearly stated.
 - a. The list of recommendation(s) shall include basis information.
 - b. If recommendations are provided as the Design Basis for an SSC, the implementation approach shall be clearly stated. Recommendations provided as the Design Basis for an SSC shall be identified on the design media.
 - c. Unverified “Assumptions” shall be documented in accordance with the vendors QA program and recommended corrective actions shall be provided to WRPS.

3.2.11 References (Required)

1. References shall be complete and available. A complete citation for references should include the following:
 - Document name
 - Document number if applicable
 - Revision number
 - Author
 - Publication date.
2. Complete or applicable sections of obscure or hard to retrieve references shall be attached.
 - a. Copyright requirements shall be met.
 - b. Process data used as input shall be included as hard copy or the source file.
 - c. Sources from the Internet shall include citation and verification of the source data. Internet sources are not a preferred source of information and should be rarely used. However, if information is obtained from these types of sources, then a documented reasonable justification is required.
3. References shall be included for all sources of input information.
 - a. Citation at point of use in the Calculation Report shall be provided.
4. Copies of reference information should be made available to the checker and organizational manager to simplify the review and approval process.

3.2.12 Calculation (Required)

This section includes the detailed calculation steps. This is presented as either a numbered section of the Calculation Report or included as an attachment or appendix.

1. The calculation shall be presented in a logical order.
 - a. Calculation sections and steps shall be uniquely identified.

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- b. Calculation sections shall be titled.
 - c. A brief description of the content of the sections should be provided.
 - d. Notations should be provided to describe the purpose or result of key calculation steps.
2. The source or derivation of equations that are not common usage shall be provided.
3. The following data shall be included in the calculation as appropriate:
 - Free Body and Moment Diagrams
 - Connection points.
 - Connection type.
 - Center of gravity.
 - Calculation or estimation of weights and justification for estimation of weight.
 - Friction forces shall be clearly shown and use shall be justified.
 - Labeling shall match calculation variables.
 - Planar/nonplanar forces and moments clearly distinguished.
 - Coordinate system clearly distinguished.
 - Geometry Diagram
 - Nodes
 - Elements (beams, shells, etc.).
4. Uncertainties introduced shall be evaluated for impact to the conclusions of the document.
5. Complex calculations or spreadsheets not readily contained within the body of the calculation are better contained in a separate appendix.
6. Information necessary to reconstruct the analysis, including hand calculations, shall be included.

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3.2.13 Design Verification

This section is required when design verification is required.

Calculations that are subject to design verification are to have this review completed prior to approval and release. This verification is to be performed by the vendor using vendor processes on the vendor produced design products, when the need for design verification is identified. The purpose of this section is for the vendor to provide evidence that the needed design verification has been performed so that the document can be approved and released by WRPS.

3.2.14 Attachments and Appendixes (Optional)

If desired the detailed calculation steps (Section 3.2.12) may be included as an attachment or appendix. Attachments and appendixes should include additional information such as computer software documentation (including spreadsheet printouts where practical), calculation review checklist(s), detailed calculations not readily contained in the main body, extensive compilations of input data, inspection reports, and copies of references, memos, or pages of manuals that are not otherwise readily retrievable from document control or records systems.

4.0 DEFINITIONS

Assumption.

- Technically Justified assumption is justified within the calculation to the extent that verification of the assumption is not required, and no further action is needed.
- Unverified Assumption is left to be verified by future actions (e.g., completion of other calculations, completion of inspections, and completion of testing).

Computation. A computation is defined by the following:

- Assumptions are not needed
- Special engineering expertise is not needed
- A permanent record is not needed (i.e., it does not need to be referenced and may easily be reconstructed)
- Engineering or technical expertise is used to evaluate the problem, and a formal calculation is not required.

Examples of computations include length of a zip cord, areas and volumes, simple thermal expansion, and simple unit conversions. There are no procedural requirements for computations.

Engineering judgment. A decision made by an engineer based on the available data to propose a design or a line of action. The judgement may be based on knowledge, experience, or comparison to equivalent or similar applications.

Imperative uses:

- “Shall” is used to indicate that a provision is mandatory.

- “Should” is used to indicate that a provision is not mandatory but is recommended as good practice.
- “May” is used to indicate that a provision is optional.
- “Will” is used to express a future state or condition, but never to indicate any degree of requirement.

Multiple-use spreadsheet. A spreadsheet or spreadsheet template to be used one time to perform a single set of calculations or analyses.

Repurposed. An engineering product that is developed using existing documentation or previously used methods as a starting point. Refer to WRPS-56532 for a description and for additional HPI tools that will help avoid errors.

Single-use spreadsheet. Spreadsheet to be used one time to perform a single set of calculations or analyses.

5.0 SOURCES

5.1 Requirements

No documents external to this procedure are required for performance.

5.2 References

5.2.1 WRPS-56532, “The Pocket Human Performance Survival Guide.”